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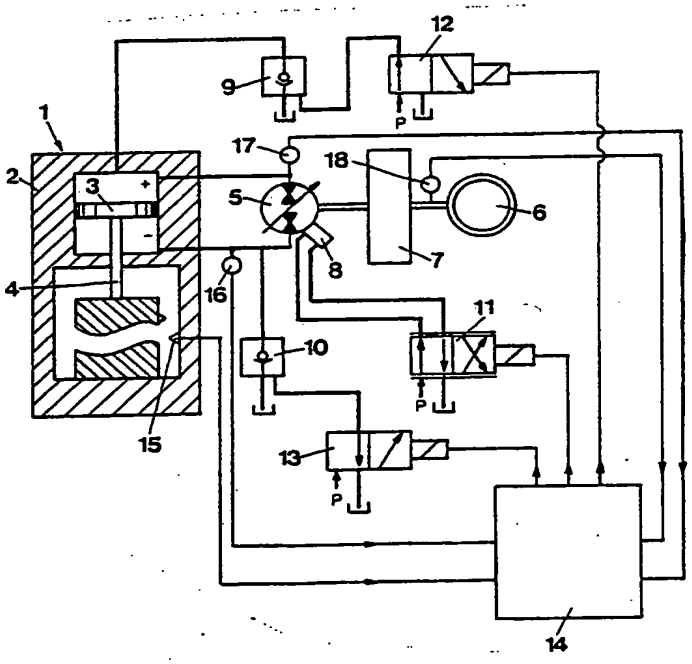
(54) Title: A DEVICE IN HYDRAULICALLY DRIVEN MACHINES

(57) Abstract

A device in machines (1) which are driven by means of a hydraulic cylinder, such as hydraulic presses and the like, and which has at least one pump (5) for the hydraulic fluid which pump is driven by a driving machine (6) through an energy accumulator, for example a flywheel (7). The object of the invention is to provide a considerable energy saving and recovery of energy. This has been achieved by at least one driving unit (5) connectable to the hydraulic system in the machine, said driving unit being arranged to bring back the elastically stored energy in the machine to the energy accumulator (7) during the decompression phase of the machine.



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A DEVICE IN HYDRAULICALLY DRIVEN MACHINES

The present invention refers to a device in machines which are driven by means of a hydraulic cylinder, such as hydraulic presses and the like, with at least one pump driven by a driving motor through an energy accumulator, i.e. a fly wheel for the hydraulic fluid.

Background of the invention

Energy storing by means of a fly wheel is utilized today at excenter presses and has been proposed for large hydraulic presses (DE-A1 1.627.843). At such hydraulic driven presses a flying wheel is arranged between the electric motor and the pump for the hydraulic fluid, in such a way that the electric motor which is necessary for the operation may be constructed relatively small, whereby an essential saving of power may be achieved. The pump must indeed be dimensioned with respect to the highest pressure which may occur and of that reason be comparatively large, but since the pressing work is executed by the flying wheel the electric motor just needs to be dimensioned for the movement of the piston. By this design a power saving is achieved, which in itself is valuable, but however no energy saving, because just a small part (a couple of percent) of the energy provided is converted to useful work and the larger part will consequently be lost.

The same applies for such driving devices for presses which use pressure accumulators for storing energy at a small total effect. An example of such a device is disclosed in SE-B-7513069-0, where the energy stored in the pressure accumulator is completely utilized, as it is not necessary to use a throttling device for converting the existing pressure in the accumulator. There is however no recovery of energy provided with this device.

A common measure in hydraulic plants is to arrange the quick transport of the piston in a press by means of an accumulator. During the return stroke the force is only a few percent of

the total pressing force, at which the accumulator is loaded. This plant only admits an insignificant storing of energy and no recovery of energy at all.

The object of invention and its most important characteristics

The object of the invention is to provide an essential energy saving, i.e. recovering of energy, at the same time as the previous advantageously power saving is maintained or even is further improved. This has been achieved thereby that at least one driving unit connectable to the hydraulic system in the machine, is arranged to bring back the elastically stored energy in the machine to the energy accumulator (7) during the decompression phase of the machine.

Through the invention the following advantages are achieved: the energy saving is obtained by that the hydraulic pump during the decompression phase is working as a hydraulic motor, whereby an energy recover of between 60-90% is obtained. The power saving is of the same size and is obtained by that the connecting power for the electric motor or motors may be decreased, which results in considerable savings in the costs for installation and connection. Further important savings of costs may be obtained for cooling of the hydraulic oil if the water for the cooling must be bought. Dependent on the water costs this saving may be up to three times higher than the saving on the electric side.

Description of the drawings

Fig. 1 shows a circuit diagram of the device according to the invention applied at a hydraulic press.
Fig. 2-4 show schematic circuit diagrams of other embodiments of the device according to the invention.

Disclosure of an embodiment

In the drawing 1 denotes a hydraulically driven machine, e.g. an hydraulic press, including a hydraulic cylinder 2 in which

a piston 3 with piston rod 4 is displaceable. A variable displacement pump for the hydraulic fluid is denoted with 5, said pump is driven by an electric motor 6 by means of a mechanical energy accumulator, i.e. a fly wheel 7. The pump 5 is provided with an adjustment element 8 in the form of a hydraulic servo, by means of which the pump may be changed from pump drive to power drive at unchanged direction of rotation of the incoming driving shaft of the pump, i.e. the shaft which is connected to the fly wheel 7.

The hydraulic system further includes two pressure controlled stop valves 9 and 10 and electrically controlled direction valves 11, 12 and 13 for controlling on one hand the adjustment element 8 and on the other hand both pressure controlled stop valves 9, 10 respectively. An electronic control system for controlling the adjustment element 8 and the stop valves 9 and 10 is denoted 14, and are controlled dependant to the signals from a position detector 15, which emits a signal related to the position or detects when the hydraulic press 1 has performed its movement, and from pressure detectors 16 and 17, which detects the hydraulic pressure at the inlet and outlet sides of the pump 5, and from a revolution indicator 18, which gives information about the rotation speed of the fly wheel. The adjustment element 8 is controlled depending on these incoming signals in such a way that when the decompression phase is started hydraulic fluid from the plus side of the cylinder 2 is fed to the pump in such a way that it will work as a hydraulic motor. Thereby the fly wheel will receive additional energy which is stored elastically in the hydraulic press 1.

This return of energy will cause the electric motor 6 to accelerate, which means, that it must be designed to withstand these changes in velocity and without that it works as a generator. One possibility is to use a continuous-current motor as an electric motor, or to disconnect the electric motor during the decompression phase by means of a free wheel.

Except the above advantages concerning energy and power saving

also a more soft operation, a more simple cooling system for the hydraulic oil and essentially lower connection costs and power charges for the electric motor are achieved. A conventionel plant, which for instance needs a pumping power of 600 kW divided into 4 electric motors, each of 150 kW, may be driven by only one electric motor of 150 kW according to the invention, which means a saving of the costs to buy and install three electric motors and the corresponding connection and power charges. Expressed in economic terms the difference in costs between different systems for a 20.000 tons press would be significant, as is evident from table No. 1.

The capitalized value for the above mentioned 20.000 tons press with flywheel and energy recovery can be calculated as follows:

Profit for a machine placed in Sweden:

Difference in investment costs: 661.000-536.000 = 125.000 SEK
" " operating costs per year and 2-shift:
215.000-75.000 = 140.000 SEK/year.

The capitalized value will be

in 10 years and 4% real interest 8,11x140.000+125.000 = 1.260.000 SEK
in 20 years and 4% real interest 13,59x140.000+125.000 = 2.030.000 SEK

in 10 years and 7% real interest 7,02x140.000+125.000 = 1.100.000 SEK
in 20 years and 7% real interest 10,05x140.000+125.000 = 1.600.000 SEK

Profit for a machine placed in Japan:

In Japan where the electricity charges for the industry is 69 öre/kwh, the difference in operating costs at 2-shift will be 485.000+75.000-(207.000+15.000) = 338.000 SEK/year

in 10 years and 4% real interest 8,11x338.000-125.000 = 2.870.000 SEK

in 20 years and 4% real interest 13,59x338.000+125.000 = 4.720.000 SEK

in 10 years and 7% real interest 7,02x338.000+125.000 = 2.500.000 SEK

in 20 years and 7% real interest 10.05x338.000+125.000 = 3.700.000 SEK

Table No. 1

Calculation of differences in costs for a 20 000 tons heat exchanger press

	Conventional system		Conventional system with fly-wheel bearing		Flywheel + recovery acc. to the invention	
	Installation	Operation	Installation	Operation costs	Installation	Operation costs
Max el powert	720 kw		250 kw		140 kw	
Mean el power	234		220		100	
Rated power	600		240		120	
El. installation	430.000 SEK		173.000 SEK		87.000 SEK	
Hydraulic pumps	130.000		190.000		332.000	
Air-oil-coding	101.000		101.000		40.000	
Flywheel	-		37.000		37.000	
Extra control-system	-		20.000		40.000	
Power charge		75.000 SEK/year		30.000 SEK/year		15.000 SEK/yea
Energy charge						
1-shift		(70.000)		(70.000)		(30.000)
2-shift		(140.000)		(140.000)		60.000
2-shift 1/2-load		(88.000)		(88.000)		(46.000)
2-skift Japan		(485.000)		(485.000)		(207.000)
	661.000SEK	215.000SEK/y	521.000 SEK	170.000 SEK	536.000SEK/year	75.000 SEK/yea

The embodiment shown in fig. 2. in which only parts of the circuit diagram, important for energy recovery are shown, differs from the embodiment of fig. 1 by the fact that a control value 20 is arranged in the hydraulic circuit between the hydraulically driven machine 1 and the pump 5. The control valve 20 is a four-way valve and is arranged to in the moment

the decompression phase is started, be switched over so that the direction of flow of the hydraulic oil from the pluis side of the piston 3 is supplied to the inlet of the pump 5, so that this will operate as a hydraulic motor and transfers its energy content to the flywheel.

In the embodiment shown in fig. 3 a hydraulic pump 21 driven by a motor 6, a pressure accumulator 22 and a hydraulic motor 23 is included in a first hydraulic circuit, while the hydraulic pump 5 mechanically driven by the hydraulic motor 23 and the hydraulic cylinder 1 form a second hydraulic circuit. For operation technical reasons it is appropriate to arrange a flywheel 7 between the hydraulic motor 23 and the hydraulic pump 5 and to design the hydraulic pump 5 so that it can be driven as a hydraulic motor at unchanged direction of rotation of the flywheel 7.

It is also possible to exclude the flywheel 7 and instead design the hydraulic motor 23 in such a way that it operates as a hydraulic pump and loads the pressure accumulator 22.

In the embodiment shown in fig. 4 the driving unit can operate either as a hydraulic pump or as a hydraulic motor dependant on from which direction the pressure medium is supplied to the driving unit. The energy recovered at the decompression phase and which by the hydraulic motor 5 is converted to rotational energy is in this embodiment supplied to the electric motor of the driving unit 5, which is so designed that i can also work as a generator and then emits the current generated to the power supply. This type of energy recovery can be appropriate in industries which have a very high consumption of electricity and where the electric power generated by the generator can be directly supplied to internal machines.

Instead of using the pump 5 as a hydraulic motor, which not always can be done, it is possible to arrange a separate hydraulic motor, which is connected in parallel with the pump and which by means of an adjustment device is connected to the

hydraulic system of the cylinder when the decompression phase begins. If the driving machine is a hydraulic motor this can be used also for the energy return.

The invention is not limited to the disclosed embodiment, but a number of alternatives are possible within the scope of the claims. Thus, the device according to the invention may be used at other hydraulically driven machines than hydraulic presses and any kind of driving machine can be used instead of an electric motor for driving of the flying wheel and the pump.

CLAIMS

1. A device in machines (1) which are driven by means of a hydraulic cylinder, such as hydraulic presses and the like, and which has at least one pump (5) for the hydraulic fluid which pump (5) is driven by a driving machine (6) through an energy accumulator, for example a fly wheel (7), c h a r a c t e r i z e d i n, that at least one driving unit (5) connectable to the hydaulic system in the machine, is arranged to bring back the elastically stored energy in the machine to the energy accumulator (7) during the decompression phase of the machine.

2. A device according to claim 1, c h a r a c t e r i z e d i n, that the driving unit (5) comprises of a pump (5) included in the hydraulic system of the machine, and which pump by means of an adjustment device (8) may be switched over from pumping work to motor work at unchanged direction of rotation during the decompression phase of the machine.

3. A device according to claim 1, c h a r a c t e r i z e d i n, that the driving unit (5) is a hydraulic motor connected in parallel in relation to the pump, said hydraulic motor is connectable to the hydraulic system of the hydraulic cylinder (2) by means of an adjustment device (8) and said hydraulic system is arranged to transfer energy of rotation to the accumulator.

4. A device according to claim 2 or 3, c h a r a c t e r i z e d i n, that the adjustment device (8) of the driving unit (5) is arranged to switch over in relation to the position of the hydraulic piston (3) after a full working cycle.

FIG 1

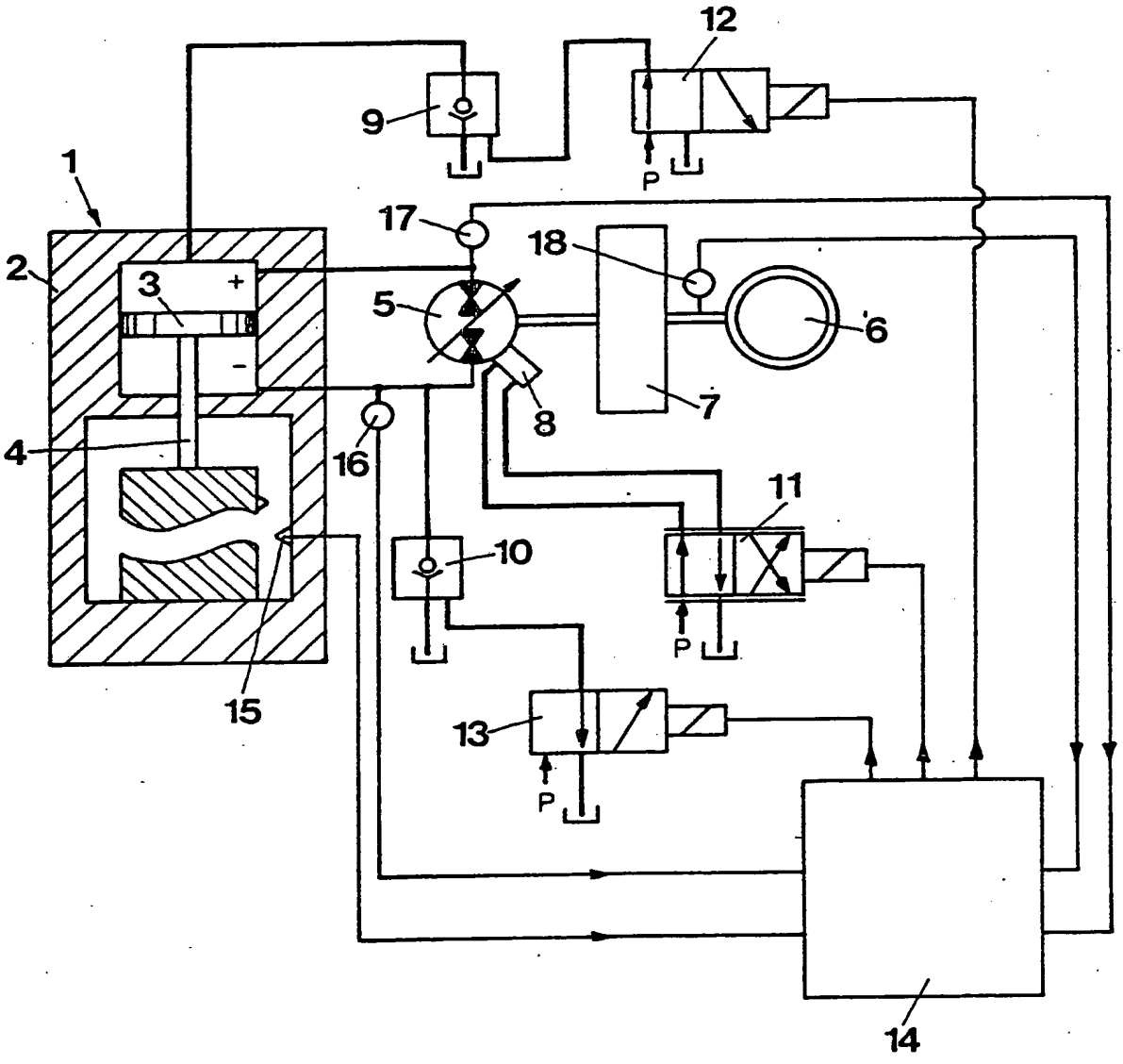


FIG 2

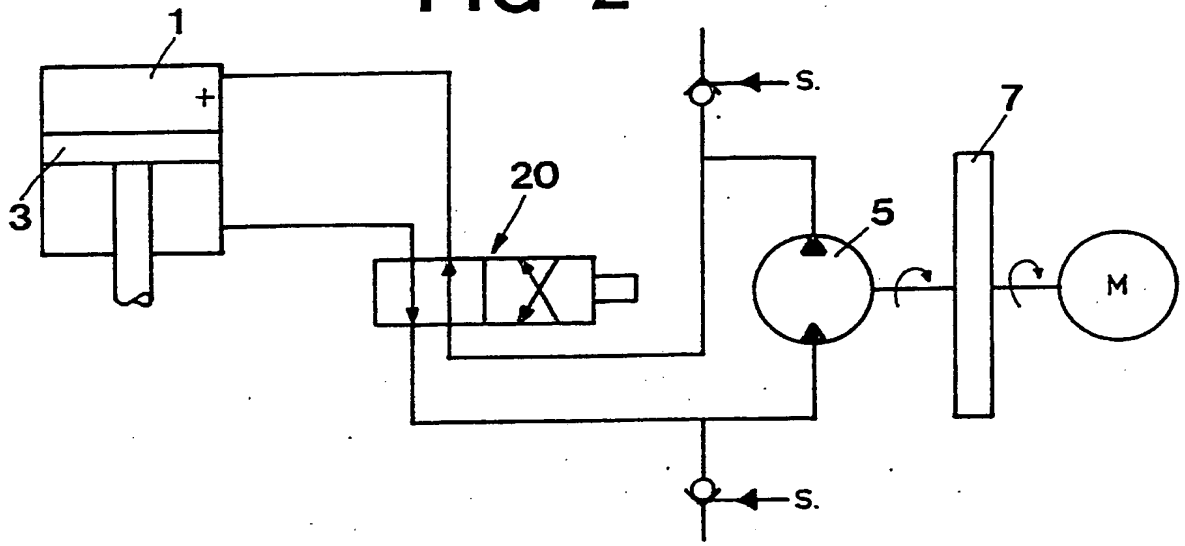


FIG 3

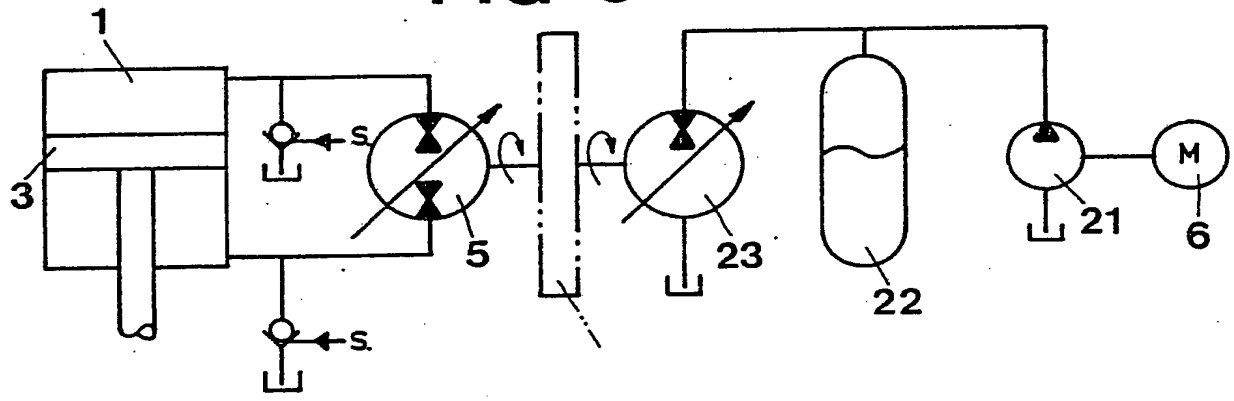
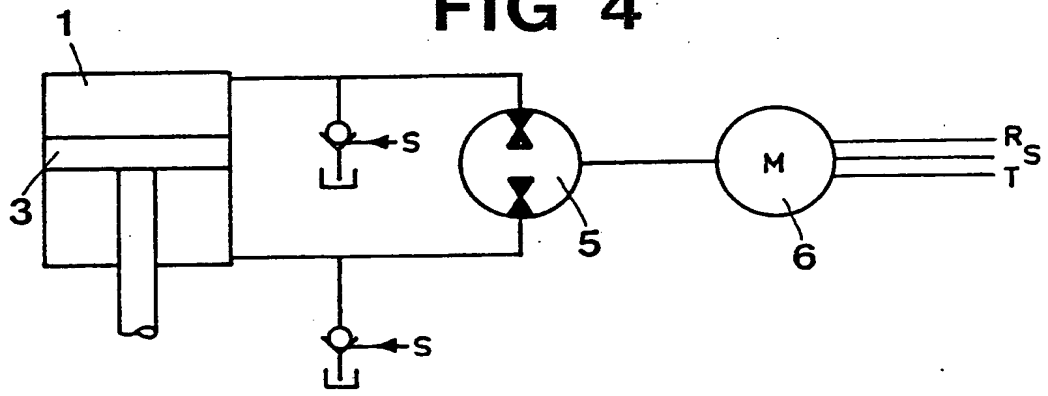


FIG 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE84/00032

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC 3

F 15 B 1/02; B 30 B 15/16

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC 3	B 30 B 1/32, 15/16; F 15 B 1/00,02; F 16 H 39/44, 46, 50, 33/08
US Cl	60: 413-418, 428, 429

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category [6]	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
A	DE, C, 556 425 (M MACK, W GRÖTZINGER) 8 August 1932	1,2
A	DE, C, 912 656 (E MÜLLER, W ZANDER) 31 May 1954	1
X	DE, B, 1 278 246 (W WINKLER) 19 September 1968	1,2
A	DE, A1, 2 809 387 (THYSSEN INDUSTRIE AG) 17 January 1980	1-4
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IV. CERTIFICATION

Date of the Actual Completion of the International Search [9]	Date of Mailing of this International Search Report [9]
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Swedish Patent Office	Per H Cederholm

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